nesting sites. Monk (1976) observed 2.47 pairs of raptors per km along 35.2 km of the Yakima River in Washington. Apparently, differences in topography between Olendorff's and Monk's study areas were marked (Knight et al. 1982). The Yakima River study area was within a steep-walled canyon with nearly continuous multi-tiered cliffs offering countless nesting sites. Knight et al. (1982) found an average of 1.21 pairs per km of river over 72 km of the Columbia River in Washington, most similiar to the density found in the BRSA. The highest concentrations of raptors reported in North America occur in the Snake River Birds of Prey Area (SRBPA) in southwestern Idaho. BLM biologists have projected an annual average of about 6 raptor pairs per km of river in the SRBPA (M. N. Kochert, U. S. Bureau of Land Management, pers. commun.).

Howard and Sather-Blair (1983) compared nesting densities of 3 raptor species (which also occur in the BRSA) in 2 sections of the Snake River Plain: the SRBPA (140 km of river) and a portion of river canyon near Twin Falls (TFSA) (36 km of river) (Table 2). The 2 areas were similar in raptor species composition, topography, soils, and vegetation. Elevations ranged from 700 m (2310 ft) in the SRBPA to 1024 m (3379 ft) at Twin Falls. Terrain was generally flat above the canyon rims. Precipitation in both study areas averaged about 23 cm. The TFSA had 73% agriculture, while the SRBPA had only 19% agriculture (measured within a 13 km corridor extending laterally from both sides of the river canyon). Overall there was a 3:1 increase in raptor nesting density in the SRBPA as compared to the TFSA (see Table 2). They considered this drastic difference in raptor density to be a result of land use patterns in the TFSA where agriculture reduced habitat for prey species used by raptors. They cautioned that similar reductions in raptor nesting densities could occur in the SRBPA if agriculture dominated the landscape.

The BRSA differs somewhat in climate, vegetation, and topography but has similar soils (deep, silty loams) and general habitat characteristics (basalt cliffs and sagebrush-grass associations) as the 2 Snake River study areas. With higher elevations present in the BRSA, the climate is cooler and the effective moisture is greater than the Snake River study areas. In addition to sagebrush-grass habitat on flat terrain, the BRSA has rolling terrain with juniper-grass associations and patches of Douglas-fir and aspen within the canyon rims, creating more structural diversity in the habitat.

Densities of 3 raptor species were twice as large in the TFSA and six times as large in the SRBPA as compared to the BRSA (Table 2). Nesting substrate did not appear to be limiting. Numerous patches of mature Douglas-fir and aspen provide nest trees for golden eagles, red-tailed hawks, and Cooper's hawks. Cliffs throughout the length of the study area offer many rock platforms and cavities on which to nest. Although cliff area was not measured during this study, inspection of cliffs in the BRSA and my familiarity with cliff characteristics in the SRBPA suggests that cliff nesting substrate was suitable in the BRSA. In addition, cliffs in the BRSA contained numerous old stick nests (built by large raptors) in areas that were not occupied by territorial raptors. This was probably a good indication that cliff nesting substrate was adequate, and that other factors may be responsible for the low densities of nesting raptors in the BRSA.

Many raptor populations have been limited by food; it is well documented that densities of principal prey species influence raptor productivity (e.g., Smith and Murphy 1979, Smith et al. 1981). Research in the SRBPA has shown that there were significant positive correlations between ground squirrel abundance and prairie falcon productivity (USDI 1979) and significant positive correlations between jackrabbit densities and golden eagle productivity (Steenhof and Kochert 1989). Because little if any information exists on prey populations in the BRSA, it is difficult to determine how prey affected the raptor populations. However, we speculate that raptors in the BRSA were limited by food.

Table 2. Comparative nesting densities of 3 species of raptors in the Blackfoot River (BRSA) (38 km), Twin Falls (TFSA) (36 km), and Snake River Birds of Prey (SRBPA) (140 km) study areas [data taken from Howard and Sather-Blair (1983)].

Species	No. nesting raptors				Nesting density nests/river km		
	BRSA[a]	TFSA[b]	SRBPA[c]		BRSA	TFSA	SRBPA
Golden eagle	6	5	33		0.16	0.14	0.24
Red-tailed hawk	5	14	57		0.13	0.38	0.41
Prairie falcon	2	5	196		0.05	0.14	1.40
Total	13	24	286	Ave.	0.34	0.66	2.04

[a] No. territorial pairs occupying sites in 1989.

[b] No. nesting raptors in 1982.

[c] Average no. nesting raptors 1975-78.

Uinta ground squirrels had a limited distribution in the study area (based on observations during this study) (Figure 5), although they appeared abundant where present. Ground squirrels were never observed within study area boundaries downstream of Womack Hill to Wolverine Creek (Figure 5). Interestingly, diurnal raptors that prey on ground squirrels (prairie falcons, red-tailed hawks, and golden eagles) were not found breeding downstream of Womack Hill (cf. Figure 4). Known locations of ground squirrels and breeding raptors were similar in distribution and it appeared that dirunal raptors were selecting nest sites near colonies of ground squirrels. In the SRBPA, the distribution of nesting prairie falcons and red-tailed hawks corresponded closely to the distribution of Townsend ground squirrels (*Spermopholis townsendii*); raptor densities were highest where squirrel numbers were greatest (USDI 1979). Prairie falcons, red-tailed hawks, and golden eagles can certainly fly long distances to catch prey [up to 25 km for prairie falcons (USDI 1979)] but foraging nearby is more energy efficient. Although percent of agriculture was not measured in the BRSA, after inspection of aerial photos, it appeared to be considerably less than that in the TFSA and similar to that in the SRBPA. We noted that most agricultural lands in

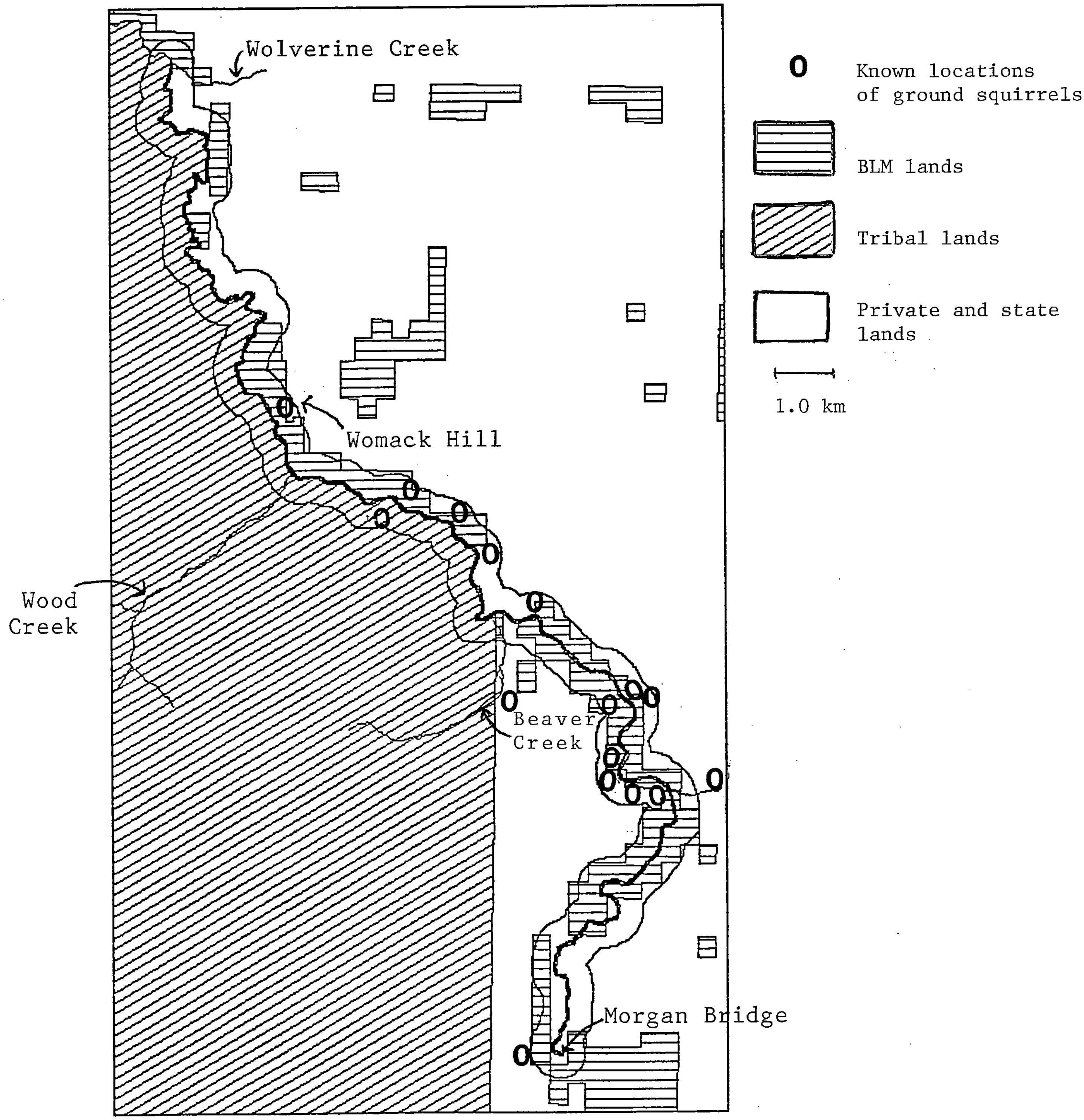

Figure 5. Known locations of Uinta ground squirrels in the Blackfoot River study area, 1989.

and adjacent to the BRSA occurred downstream of Womack Hill, where ground squirrels were not observed (Figure 5). Type of agriculture, which differs between the BRSA and the Snake River study areas, could have different effects on prey species. Agriculture in the BRSA is primarily dryland, whereas irrigated agriculture dominates the Snake River study areas. Irrigated agriculture usually stays greener longer and provides more succulent vegetation; thus, probably being more palatable to ground squirrels. Soils can also affect the distribution of ground squirrels because textures must be suitable for burrowing. We hypothesized that soils would be different in squirrel use and non-use areas but found there were no differences (see USDA 1973).

During this study, only 11 white-tailed jackrabbits were seen from the road over 1459 km (912 mi.) travelled in the BRSA and peripheral areas (included those jackrabbits seen within 5 m either side of the road) . By contrast, 101 black-tailed jackrabbits were observed from the road over 710 km (444 mi.) travelled in the SRBPA from 15 May to 3 June 1989 (J. Doremus, U. S. Bureau of Land Managemnt, pers. commun.). This indicates that jackrabbit numbers were extremely low in the BRSA, possibly explaining the low percentage of golden eagles that attempted to breed in 1989 (see discussion below). Jackrabbit populations are cyclic and usually peak every 10 years. The last peak in rabbit numbers occurred in 1981-82 in southeastern Idaho, so they should be expected to peak again in 1991-92.

Golden Eagles

Pairs of golden eagles occupied 5 territories, and a single adult was observed near an old eagle nest on 2 different occasions (Appendix F). Nests were built on cliffs in all territories and alternate nests at 2 of 6 sites were built in trees (Table 3). One breeding attempt was recorded during the inventory (Figure 4). Nest fate was not determined for this nest; however, the 1 young produced appeared healthy and near 80% of fledging age (ca. 46 days vs. 51 days for 80% fledging) when last seen in the nest on 19 June. Breeding chronology was determined by back-dating from dates of known activities. Chronology was as follows: courtship -February/late March; incubation - 22 March/4 May; hatching - 4 May; brood-rearing - 4 May/7 July; and fledging - 7 July. This chronology averaged 3 weeks later than that reported for golden eagles in the SRBPA (USDI 1977).

Assuming that there were 6 occupied territories, only 17% or 1 pair of eagles was known to breed (Table 1, Figure 4). This percentage was extremely low compared to the percent of eagle pairs occupying territories that laid eggs (39-100%) in the SRBPA from 1971 to 1988 (Steenhof and Kochert 1989). It could be that we were unable to locate the nests used for egg-laying. We intensively searched all cliffs and forest patches within the canyon rim but perhaps some pairs nested in trees outside the canyon. More likely, low numbers of jackrabbits (principal prey of golden eagles) were probably associated with the low percentage of eagle pairs that laid eggs. Steenhof and Kochert (1989) found that jackrabbit abundance was significantly and positively correlated with the percent of eagle pairs that attempted to breed in the SRBPA over a 17-year period. Other raptors are known to remain in nesting areas but do not lay eggs during periods of low prey abundance (Southern 1970, Adamcik et al. 1978, Village 1981).

Table 3. Structure and habitat of occupied nest sites in the Blackfoot River study area, 1989.

	No. nests				
	Structure/Habitat				
Species	Cliff/ Sagebrush	Cliff/ Agriculture	Tree/ Aspen	Tree/ D.Fir	Tree/ Juniper
Golden eagle	6			2[a]	
Red-tailed hawk	1		2	2	
Cooper's hawk				3	
Prairie falcon	2				
Great horned owl[b]	2	1	1	1	2
Northern saw-whet owl[b]			1	3	

[a] Alternate nests not decorated this year.

[b] Nests not actually found; based on owl calls and visual locations in those habitats.

Mean distance between adjacent occupied sites for golden eagles was 3.63 km (range 1.94-5.17 km) (Table 4). This was similar to that reported by Phillips et al. (1984) where the mean distance between sites was 3.4 km in a sagebrush-mixed riparian habitat in southern Wyoming. Phillips et al. (1984) also reported an overall mean distance of 5.3 km (range 3.1-8.2 km) for 12 survey areas in Wyoming (including the area above), which included habitats of pine-grassland, grassland-rimrock, sagebrush-agriculture, sagebrush-rimrock, and grassland-agriculture. They explained that golden eagle territories appeared evenly spaced in many parts of Wyoming where nest sites were abundant. Golden eagle nests associated with ponderosa pine (*Pinus ponderosa*) and cottonwood (*Populus* spp.) forests were more closely spaced and evenly distributed than those in open sagbrush-grassland where nest trees were scarce. In north-central Washington, the average distance between occupied nests of golden eagles was 11.5 km (Knight et al. 1982), much larger than that in the BRSA. The mean distance between nearest adjacent pairs in the SRBPA was 3.47 km (USDI 1979), very similar to that observed in the BRSA and in Wyoming.

Table 4. Raptor density and spatial relationships along 38 km of the Blackfoot River, Bingham County, Idaho, 1989.

Species	No. Pairs	Mean distance between adjacent occupied sites (km)	Range of distance between adjacent occupied sites (km)
Golden eagle	6	3.63	1.94 - 5.17
Red-tailed hawk	5	3.40	0.55 - 4.86
Cooper's hawk	3	3.74	3.30 - 4.17
Prairie falcon	2	6.67	----
Great horned owl	7	4.06	1.42 - 8.01
Northern saw-whet owl	4	3.42	0.66 - 8.83

Minimum distances between eagle pairs in the SRBPA and the TFSA were 0.96 km and 4.34 km, respectively (USDI 1979, Howard and Sather-Blair 1983). Differences in golden eagle territory size reflect differences in habitat types, prey densities, local topography, and nesting densities (Collopy and Edwards 1989). Golden eagles in the BRSA occupied sites in relatively close proximity compared to the other mentioned study areas. Perhaps the diverse topography, characterized by the winding river, hills, and trees, provided visual barriers allowing the eagles to be more tolerant of their neighbors.

Red-tailed Hawks

Five pairs of red-tailed hawks occupied territories (Appendix G), and 4 of these were known to breed (Figure 4). Nest fate was successful for 2 pairs and unknown for the other 2. Breeding chronology was determined by back-dating from dates of known activities and chronology was as follows: courtship - late March/early May; incubation - 16-29 April/16-29 May; hatching - 16-29 May; brood-rearing - 16-29 May/24 June-7 July; and fledging - 24 June/ 7 July. This chronology averaged 3 weeks later than that reported for red-tailed hawks in the SRBPA (USDI 1977).

Eighty percent of the nests were built in trees (Table 3), indicating that redtails in the BRSA (where cliffs were abundant and appeared suitable) preferred trees to cliffs for nest placement. Two nests were built in mature aspens and the other 2 in mature Douglas-firs. Nests were built in the larger trees of forest patches, and exhibited good visibility of the area surrounding them. Alternate nests found in territories occupied by tree-nesters were in trees. We did not find any alternate nests in the territory occupied by the cliff-nesting redtail.

Mean distance between adjacent occupied sites for red-tailed hawks was 3.40 km (range 0.55-4.86 km) (Table 4). The minimum distance between nests in the BRSA (0.55 km) was similar to that in the SRBPA (0.34 km) but much closer than those in north-central Washington (2.7 km) and the TFSA (1.93 km) (USDI 1979, Knight et al. 1982, Howard and Sather-Blair 1983). In Washington and the Snake River study areas, redtails nested primarily in cliffs, whereas redtails in the BRSA nested primarily in trees. Tree nesting and the diverse topography in the BRSA provided visual barriers, probably allowing the hawks to nest closer.

Prairie Falcons

Two pairs of prairie falcons occupied territories (Appendix H) and both were successful breeders (Appendix D). Breeding chronology was determined by back-dating from dates of known activities and chronology was as follows: courtship - late March/April; incubation -26 April/27 May; brood-rearing - 27 May/5 July; and fledging - 5 July. This chronology averaged 3 weeks later than that reported for prairie falcons in the SRBPA (USDI 1977).

This density of prairie falcons (0.05 nests/river km) was extremely low considering the availability and quality of cliff nesting substrate. Prairie falcon densities were nearly 3 and 28 times as large in the TFSA and SRBPA, respectively (Table 2).

Some prairie falcons might not have been detected during the survey, although we surveyed the full length of the study area twice. By the time of egg-laying (26 April), we had completed the first ground search of the study area, and by hatching (27 May) we had completed the second full survey of the study area. Allen (1987) reported that about 22% of occupied prairie falcon aeries might not have been seen during a single ground survey if they had not been previously known. Investigator nest visits do not always elicit a response by adults. Some adults may be secretive, and many are less defensive and less visible near their nests after nesting failures (Allen 1987).

The density of ground squirrels (principal prey for prairie falcons) and their patchy distribution probably influenced the density of nesting prairie falcons. Drought conditions for 2 consecutive years (1988-89) in southeastern Idaho might have reduced ground squirrel numbers, which could have reduced occupancy by prairie falcons. The population density of Townsend ground squirrels in the SRBPA was reduced by more than one-half as a result of the 1977 drought (Smith and Johnson 1985). Two years before the 1977 drought prairie falcons occcupied an average of 90.5% of preselected traditional sites, but after the drought occupancy dropped to an average of 76.5% in 1977 and 1978 (USDI 1979). Percent of prairie falcons breeding also dropped; between 1974-78 the percentage of breeding attempts was lowest in 1977. These reductions in occupancy and breeding were explained by the lower densities of ground squirrels in the SRBPA (USDI 1979).

Cooper's Hawks

Three pairs of Cooper's hawks occupied territories and attempted to breed (Appendix I); 2 were successful and 1 nest fate was unknown. Breeding chronology was determined by back-dating from the estimated age of young and averaging the dates for the 2 successful nests. Chronology was as follows: courtship - mid April/May; incubation -24 May/24 June; brood-rearing - 24 June/23 July; and fledging - 23 July. This chronology averaged 10 days later than that reported for Cooper's hawks in Oregon (Reynolds 1983).

Cooper's hawks retain juvenal plumage for 1 year and generally do not breed the first year (Reynolds and Wight 1978). We found a female in juvenal plumage breeding successfully at Short Creek Butte. Others have reported Cooper's hawks in juvenal plumage breeding successfully (Moore and Henny

1984). Raptors breeding in juvenal plumage may be evidence of favorable breeding conditions or higher numbers of unoccupied territories (Newton 1979). In the BRSA, we found 1 unoccupied Cooper's hawk nest and, based on available habitat, we suspect that there were others.

Cooper's hawks demonstrated the most narrow use of habitats for nest sites, using only Douglas-firs (Table 3). Nests were constructed in the medium-sized trees within forest patches and were placed about 10-12 m up the tree. All nests were located on moderately steep (ca. 25-35% slope) and north-facing slopes. Two nests were on horizontal limbs against the trunk and one was in the crotch of a double trunk. All nests were immediately below the nest-tree crown. Characteristics of slope, aspect, and nest placement were similar to those reported for nests of Cooper's hawks in Oregon (Reynolds et al. 1982).

Cooper's hawks are known to nest in deciduous forest patches, especially along stream courses, in the western United States (see Jones 1981). We expected to find Cooper's hawk nests in aspens but none were found there. In early May, 1 Cooper's hawk in an aspen patch responded to the recording of the great horned owl song. The only other Cooper's hawks associated with aspens in our study area were those that appeared to be hunting.

Reynolds et al. (1982) explained that the tendency for Cooper's hawks (and Accipters generally) to nest on northern and eastern aspects demonstrated a preference for cooler, more protected sites. They theorized that having evolved primarily in woodland habitats, accipiters may have low tolerances of high temperatures and direct sunlight. This could explain why Cooper's hawks in the BRSA selected Douglas-fir over aspen. Douglas-firs grew on moderately steep, north- and east-facing slopes, which provided cooler, more protected sites. Aspens tended to grow on gentler, more exposed terrain, probably creating a warmer microclimate.

Great Horned Owls

Broadcasting tape recordings of owl songs elicited vocal responses on 6 occasions and approach on 1 occasion by great horned owls. In addition to responding to horned owl songs, great horned owls responded to the song of long-eared owls. Based on these responses, we assumed that there were 7 potential breeding territories (Appendix J). Judging from this information, the great horned owl was the most common raptor in the study area. No nests were located in the study area; however, we determined breeding chronology from a nest near the study area boundary. Chronology was as follows: courtship - February/March; incubation - 21 March/24 April; hatching - 24 April; brood-rearing (approximate time in the nest before branching) - 24 April/1 June; and fledging (attaining flight) - 3 July.

Great horned owls displayed the greatest use of habitats for territory and/or nest sites (Table 3), indicating that they were the most adaptable raptor in the study area. They were found in all cover types except riparian, where nest structures were limited. Horned owls do not build their own nests; they use abandoned nests built by other raptors and corvids, and a variety of other structures including cliffs. We searched for large stick nests in riparian areas before leaf-out. We were hoping to find horned owls and long-eared owls using old corvid nests but found only a few unoccupied magpie nests.